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Strong thermal x-ray emission from a small source ($\sim 10^6$ cm) is a signature to be expected from a superdense star, such as a neutron star (Wheeler, 1966). It is the purpose of this letter to point out that the superdense star hypothesis for a thermal x-ray source may be tested by measuring the statistical fluctuations in the observed x-ray photon count. As an example, this is shown to be a practical test for the x-ray star Sco X-1.

As first noted by Einstein (1909-1912) and much discussed recently in connection with quantum optics (Mandel and Wolf, 1965, McLean and Pike, 1965), the photon count (n) for a thermal source exhibits a statistical variance given by

$$\langle (n - \langle n \rangle)^2 \rangle = \langle n \rangle (1 + \delta) \tag{1}$$

where δ is the expectation value for the photon population per unit cell (h^3) of phase space, for each of the two spin degrees of freedom.

For independent classical particles the variance would include only the first term of (1); i.e. the variance would be $\langle n \rangle$. However, photons are Bosons associated with fields that interfere and hence are not completely independent. The value of δ gives the deviation from the classical particle statistical variance in the count to be expected for thermal photons.

The quantity δ of Equation 1 may be expressed as

$$\delta = \frac{\lambda^3}{2c} \cdot \left(\frac{I}{\Omega} \right) \tag{2}$$

where I is the spectral intensity (ergs/erg-cm^2-sec) at a wavelength λ, from a source that subtends a solid angle Ω; (c) is the velocity of light.

Note that the relation (2) between the measured variance of the photon count (1) and the measured spectral intensity (I) at λ gives the solid angle Ω subtended by the source when this information refers to thermal radiation; a small source enhances the statistical variance.

The x-ray source Sco X-1 has been measured (Gursky et al, 1965) to be a stellar (< 20") object and the optical counterpart is estimated to be at a distance of about 8×10^2 light years (Sandage et al, 1966). If Sco X-1 is a superdense star (Shklovsky, 1967) of radius $r \approx 10^6$ cm, then the angular size of the source is about 10^{-9} arc seconds, which is far beyond the angular resolution capability (~ 1 arc second) of the grazing incidence x-ray telescope (Vaiana et al, 1968). In contrast, for the intensity from Sco X-1 measured (Grader et al, 1968) at $\lambda = 10\mathring{A}$ ($I \approx 10^2$ ergs/erg-cm^2-sec), the situation of a superdense star of radius $r \approx 10^6$ cm as the source of x-rays would give the significantly large value of $\delta = 1/3$. That this is a sensitive measure of the size of a small source may be realized by noting that for an alternate hypothetical situation where Sco X-1 is comparable in size to the sun ($r \approx 10^{11}$ cm) the enhanced fluctuations would essentially vanish since in this case $\delta < 10^{-10}$.

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